Umblical Cord Coiling Index as a Marker of Perinatal Outcome

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Abstract
Aim: To measure umbilical coiling index postnatally and to analyze whether umbilical coiling index measurement could predict adverse perinatal outcome.

Materials and methods: A study designed was a prospective observational study, enrolled total 100 singleton pregnancies, who were fulfilling inclusion criteria. The length of the cord was measured using a non-stretchable inch tape. The umbilical cord was measured in its entirety, including the length of the placental end of the cord and the umbilical stump on the baby. Various outcome measures like gestational age at birth, intrauterine growth retardation, birth weight, meconium staining, APGAR scores at 1 and 5 mins were observed. Statistical analysis was done and $p<0.05$ was considered as significant.

Results: In present study, 79% had normocoiling while 11% had hypocoiling and 8% had hypercoiling of cord. Of these, 5% had preterm deliveries which was statistically significant ($p = 0.04$). Also, meconium-stained liquor was noted in 10% cases, among which 50% had abnormal coiling index. This was statistically significant ($p = 0.008$).

Conclusion: Abnormal umbilical coiling index is associated with adverse perinatal outcomes.Hence measuring coiling index antenatally can help in predicting adverse perinatal outcomes resulting in closer fetal monitoring and improved fetal outcome.

Keywords: Hypocoiling umbilical cord, Hypercoiling umbilical cord, Umbilical coiling index

INTRODUCTION

Umbilical cord, derived from Latin word *funiculus umbilicalis*, is a narrow cord of tissue that connects a developing embryo or fetus with the placenta.[1]Umbilical cord has three blood vessels, 2 arteries and one vein which is susceptible to kinking, torsion and compression which may affect the perinatal outcome. Normally, these vessels are encased by Wharton's jelly. Also, amniotic fluid and helical coiling of blood vessels provide protection to them. This helical arrangement of umbilical vessels is called spiral course.[2]

About 95% of the umbilical cords have coils and the origin of the coiling is unknown.In 1954, umbilical coiling was first measured by Edmonds HW et al. who quantified the umbilical coiling by dividing the total number of coils with umbilical cord length and called it as "The Index of Twist".[3]The positive and negative scoring was assigned to clockwise and anticlockwise coiling of the umbilical cord. But Strong TH et al. simplified this classification by eliminating these directional scores and renamed it as "The Umbilical Coiling Index" (UCI).[4] Hypocoiled and hypercoiled cords were defined as coils having UCI less than 10th percentile and more than 90th percentile respectively.These abnormal coiling index has been reported to equate with adverse perinatal outcome.[8] Umbilical cord with its blood vessels are most vulnerable part of fetus. Umbilical coils are believed to be formed in early gestation. The coiling pattern develops in second and third trimesters, due to curls in cord as pregnancy advances coiling changes.

Various reports have shown that abnormal coiling index is associated with adverse perinatal outcomes.[5] As there are inadequate studies to support this hypothesis in an Indian scenario, this study was undertaken to find out the umbilical coiling index and its relationship with perinatal outcomes.

Normal value of coiling index is calculated approximately as 1 coil/5 cm of umbilical cord length or 0.20–0.24 coils/cm.[9] In the present study aim is to measure umbilical coiling index (UCI) postnatally and to study the association of normocoiling, hypocoiling and hypercoiling to maternal and perinatal outcome.

MATERIALS AND METHODS

The study was conducted at the Department of Obstetrics and Gynecology, Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry. The proforma was submitted to the ethical committee of our hospital. The committee concluded that the present study was exempt.

During the study period placentas and umbilical cords of 100 newborn babies were observed by one person who was blinded to the patient characters and the pregnancy outcomes. All specimens were unfixed. The length of the cord was measured using a non-stretchable inch tape manually. The umbilical cord was measured in its entirety, including the length of the placental end of the cord and the umbilical stump on the baby. The number of complete helices of the umbilical vessels was counted from the neonatal end towards the placental end. A coil was defined as a complete 360-degree spiral course of the umbilical vessels around the Wharton's Jelly.

As introduced by **Strong et al** [12]

$$\textbf{Umbilical Coiling Index} = \frac{\textbf{Number of coils}}{\textbf{Cord length in cms}}$$

The direction of cord coiling (sinistral, dextral) was also reported. The coiling pattern was also described as being sinistral if the course of the umbilical helix was from right to left, anti-clockwise. As in previous studies, the umbilical cord coiling index was classified as hypocoiled if the cord coiling index was smaller than the 10th percentile, normocoiled if the umbilical cord coiling index was between 10th and 90th percentile or hypercoiled if the umbilical cord coiling index was above the 90th percentile.

The following data was collected :

Pregnant ladies of ≥ 28 weeks of gestation having singleton live baby irrespective of parity and the mode of delivery were included in study. The pregnant women with multi foetal gestation and having history of congenital malformed babies were excluded. Base on the selection criteria One hundred pregnant women were taken in to the study. After separating the baby from the umbilical cord, the cord was tied and cut closed to the placenta. Without being stretched, the cord was examined initially on the examination table. The entire umbilical cord was measured in centimeter including the Umbilical Coiling Index and Its Relationship with Perinatal Outcomes.

The placenta and umbilical cord were examined for the umbilical cord length, the number of umbilical coils, insertion of the cord and for the presence of two umbilical arteries and one umbilical vein. Microscopic examination of the placenta of the placenta for signs of chorioamnionitis funisitis, chronic hypoxia was not done.

RESULTS

Out of 100 cases, 79 of the subjects showed normal coiling index, 11 with hypocoiling and 10 with hypercoiling of the umbilical cord. A total of 59 cases were primigravida with 13 showing abnormal coiling index while among 41 multigravidas only 8 had abnormal coiling (Table 1). This data was rather insignificant making clear that coiling index might not alter with parity (*p* value = 0.546). Among 21 patients with abnormal coiling pattern, 3 patients had preterm deliveries and of 79 patients with normal coiling, 2 had preterm delivery (*p* value = 0.046). Out of 10 patients who delivered with meconium-stained liquor 4 showed hypocoiling and 1 had hypercoiling (Table 1). This data was statistically significant proving that hypocoiling can be strongly associated with meconium-stained liquor (*p* value = 0.001). A total of 75 patients delivered vaginally; 25 patients delivered by lower segment cesarean section. Most common indication for lower segment cesarean section was meconium-stained liquor and fetal distress. Present study

shows that abnormal coiling of cord could not predict the mode of delivery. Different cord insertions observed were: central in 75 placentas, eccentric in 14 and marginal in 11 placentas as shown in Table 1.
Among total cases, 51 patients had intrauterine growth restriction (IUGR). Out of these four had hypocoiling and five had hypercoiling of cord. A total of 49 patients delivered appropriate for gestational age (AGA) baby out of which 7 showed hypocoiling and 5 showed hypercoiling (Table 1). The present study could not prove any association between abnormal coiling and IUGR (*p* value = 0.57). Further studies with larger sample size are needed to study this association.
Only one newborn died during early neonatal period. Perinatal outcome was evaluated in the form of Apgar score and adverse events developed in neonates. Apgar score of 7–10 at the 1st minute is considered to be normal. Table 2 shows the frequency of Apgar score at 1 and 5 minutes. There was no difference among the three groups in Apgar score at 1 and 5 minutes as shown in Table 3.

DISCUSSION

It is now justified that there is clinical correlation between perinatal outcome and umbilical cord coiling. Several trials had been conducted in the past which have shown the relationship between perinatal outcome and the umbilical cord coiling. Similarly, in the present study, perinatal factors like meconium staining, birth weight, Apgar score at 1 minute and 5 minutes , mode of delivery, NICU admission, gestational agewas correlated with umbilical cord coiling.
The women included in present study were ranging from 18 years to 35 years of age. Majority of them were in age group 25–29 years. This had no statistical significance. Distribution of gravidity shows that the majority of women were primigravida (59) of these 79% had normocoiling, 11% had hypocoiling and 10% had hypercoiling (*p*value—0.546). 25% underwent LSCS out of these 72% had normocoiling, 20% had hypocoiling, 8% had hypercoiling. 75% underwent vaginal delivery and 81.3% had normocoiling, 8% had hypocoiling and 10.6% had hypercoiling (*p* value—0.247), thus the mode of delivery could not be predicted by coiling index

Table 1: Comparison of perinatal factors among different umbilical cord coiling index groups

Perinatal factors		***UCI group***			***Total***	***p value***
		<10th percentile (hypocoiled)	***10th–90th percentile (normal coiled)***	***%3E;90th percentile (hypercoiled)***		
Gravida	Primigravida	8	46	5	51	0.546
	Multigravida	3	33	5	49	
Maturity at birth	Full term	10	77	8	95	0.046
	Preterm	1	2	2	5	
Liquor color	Clear	7	74	9	90	0.008
	MSAF	4	5	1	10	
Delivery	Normal	6	61	8	75	0.247
	LSCS	5	18	2	25	
Birth weight	<10th centile	4	42	5	51	0.57
	>10th centile	7	37	5	49	
Cord attachment	Central	15	58	2	75	_
	Eccentric	2	11	1	14	
	Marginal	1	9	1	11	

Table 2: Apgar score at 1 minute and 5 minutes			
Apgar score	*Apgar value*	*Frequency*	*Percent*
Apgar 1 minute	<7	4	4.0
	7	8	8.0
	8	88	88.0
Apgar 5 minutes	<7	1	1.0
	7	1	1.0
	8	5	5.0
	9	93	93.0

A meta-analysis conducted by Gupta et al. showed that hypocoiling is associated with increased incidence of fetal demise, intra partum fetal heart rate decelerations, operative delivery, fetal distress and chorioamnionitis.[3] In current study, birth weight was correlated to umbilical cord coiling. It was found that out of 100 babies delivered, 51 were found to be IUGR, i.e., <2.5 kg, among which 82.4% had norm coiling, 7.8% had hypocoiling and 9.8% had hypercoiling. Rest 49 babies with normal birth weight showed normocoiling in 75.5%, 14.2% showed hypocoiling and 10.3% showed hyper coiling. The *p* value (0.57) for this was statistically insignificant, thus abnormal coiling index cannot help in predicting higher incidences of IUGR. But we found significant association between abnormal coiling and preterm labor (*p* value = 0.046). Thus, measuring coiling index might be helpful in having suspicion for preterm labor and with close fetal monitoring adverse perinatal outcome could be predicted. This result of present study was compared with the study done by Rana et al.[2] and Raio et al.[8]

Table 3: **Comparison of Apgar score (at 1 and 5 minutes) among different umbilical cord coiling index groups**				
Apgar score	*UCI groups*	*N*	*Mean*	*p value*
Apgar-1	<10th percentile	11	7.91 ± 0.302	0.955
	10th–90th percentile	79	7.94 ± 0.462	
	>90th percentile	10	7.90 ± 0.316	
Apgar-5	<10th percentile	11	9.00 ± 0.000	0.878
	10th–90th percentile	79	8.95 ± 0.450	
	>90th percentile	10	9.00 ± 0.000	

Out of the total cases, 10% had meconium-stained liquor of which 50% were with normal coiling, 40% with hypocoiling, and 10% with hypercoiling. Total 90% had clear liquor of which 82.2% showed normal coiling, 7.8% showed hypocoiling, and 10% showed hypercoiling. Thus, helping in proving that abnormal coiling can be associated with MSAF (*p* value = 0.008). Similar results were noted in previous studies.[3,5,9–11]

Apgar at 1 minute and 5 minutes was not found to be statistically significant. But other similar umbilical cords studies[3,9,12] showed that under coiling was associated with low Apgar scores. Padmanabhan et al.[9] studied 130 umbilical cords and found that hypocoiling of cord was associated with low Apgar scores. Indeed, over-coiling per se, even without cord stricture, alone has been documented at autopsy in 23% of unexplained fetal deaths.[13]

CONCLUSION

From the results of present study, we concluded that abnormal coiling index can be associated with preterm labor and by closely monitoring these high-risk fetuses, such adverse outcomes can be declined. Also, study found that hypocoiling might lead to meconium-stained amniotic fluid. Hence measuring coiling index antenatally can help in predicting adverse perinatal outcomes resulting in closer fetal monitoring and improved fetal outcome.

CLINICAL SIGNIFICANCE

Umbilical cord coiling index can prove to be a very helpful aid to screen patients at risk of adverse perinatal outcome.

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